GLACIAL STUDIES IN GREENLAND. VIII.

The Krakokta Glacier. — Of the glaciers that descend northerly from Redcliff Peninsula, the Krakokta is the most important and instructive. It takes its rise in the north central portion of the nevè field of the plateau and descends a relatively long valley by a series of moderate cascades, rather than the single one which characterizes the descent of the glaciers previously described. The last of these cascades lies opposite the head of Bowdoin Bay, at the point where the plateau gives place to the lowland that connects it with the mainland. On descending this, the glacier spreads out upon the lowland into a broad, flaring foot, the right-hand portion of which immediately overlooks the head of the bay, while the central portion is forced into direct contact and conflict with the Tuktoo glacier which descends into the same lowland from the main ice-cap on the north, and the left-hand side spreads out upon the flats toward the head of McCormick Bay. In descending this lower cascade the ice is much broken and presents a very ragged aspect, but I did not observe that it differs in any notable way from the analogous ice cascades of southern glaciers.

The collision of the Krakokta and the Tuktoo glaciers, gives rise to a very interesting joint moraine. The Krakokta glacier coming from the south carries chiefly red sandstone in its basal layers. The Tuktoo glacier coming from the north carries chiefly gray crystalline rock. This contrasted material has been heaped up into a single sharp ridge, the south side of which is red from the dominance of the sandstone, while the north side is gray from the dominance of the crystalline rock. The contribution of each glacier is thus strikingly displayed. The dividing line between these contributions runs essentially along the crest of the moraine. Each glacier seems to have done an equable share of the work of forming the moraine. It should be said, however, that I only examined the eastern part of

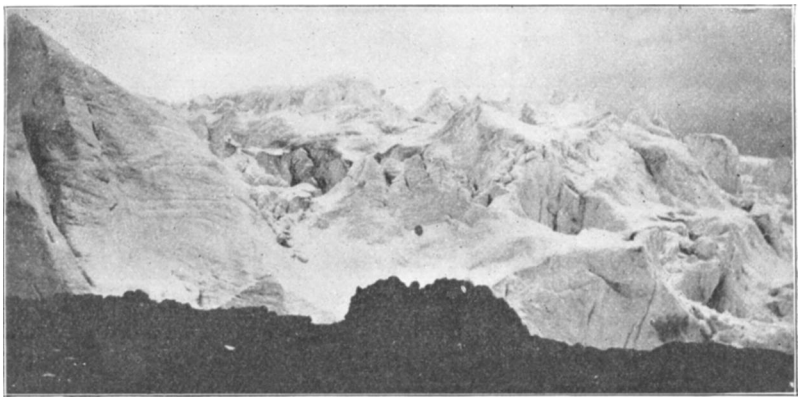

FIG. 52.—Seracs of the lower cascade of the Krakokta glacier.

FIG. 53.—View of the lower part of the Krakokta cascade looking northwesterly. The dark line which crosses the figure near the center is a *joint* terminal moraine, formed by the contact of the Krakokta and Tuktoo glaciers, moving from opposite directions, the former from the south, the latter from the north. Beyond the moraine near the extremity of Tuktoo glacier, a small nunatak is seen at the right of the figure, around which the ice is depressed. The larger prominence in the center separates the Tuktoo glacier from the Sun glacier. The snow-cap on the heights at the left in the distance is the edge of the ice-cap of Prudhoe Land, and is continuous with the main ice-cap, which lies to the right.

the moraine and this remark may not apply to the western portion where the moraine seemed, from a distance, more deployed and complex. In the portion examined, the glaciers still press against the base of the moraine, but not forcibly. There is a slight valley between the moraine and the ice on either side, though this is not of such depth or steepness as to offer any serious difficulty in passing from glacier to moraine, or moraine to glacier on either hand. The moraine rises but little above the ice on either side, as will be seen by reference to Fig. 54, which is a view of the east end at the point where the glaciers are separated by the Sentinel nunatak.

The surface of the ice adjacent to the moraine is almost wholly free from débris. That which is contributed to the formation of the moraine is borne by the basal layers of the ice on either hand. In the vicinity of the moraine the layers of the ice are curved upwards. This upward curvature of the strata is not, however, confined to the edge of the ice in contact with the moraine, nor indeed to the immediate border of the glacier. In crossing the wide expanse of the foot of the Krakokta glacier, it was observed that the blue layers — which best indicate the stratification of the ice where débris is absent — were continually coming to the surface by an upward curvature which increased as the surface was approached. This gave a beautiful structural expression to the surface of the ice, the layers being delineated in long, graceful, curving lines, concentric with the border of the glacier. It seemed very manifest that, at least in this glacier, the blue and white bands, which appear as stratification in the vertical faces, assume the form of highly inclined folia on the glacier's surface, closely analogous, if not identical, with the much discussed "ribbon structure" of Alpine glaciers.

The eastern border of the foot of Krakokta glacier, between the point of junction with the Tuktoo glacier and the ice cascade previously mentioned, is unusually interesting from the varied relationships which it sustains to the terminal deposits. For some distance southeast from the point of contact with the Tuktoo glacier it lies opposite the Sentinel nunatak. For the rest of the distance around to the cascade it lies opposite the

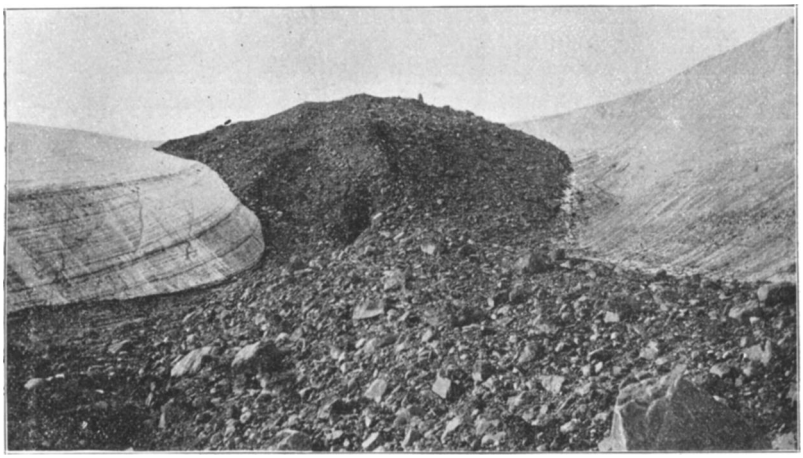

FIG. 54.—A *joint* terminal moraine formed by the direct opposition of the Tuktoo glacier, which is seen on the right, and the Krakokta glacier, which is seen on the left. The point of view is opposite the east end of the joint moraine near the Sentinel nunatak looking westerly. The photograph shows the stratification of the ice and in some measure the upward curving of the layers near the moraine.

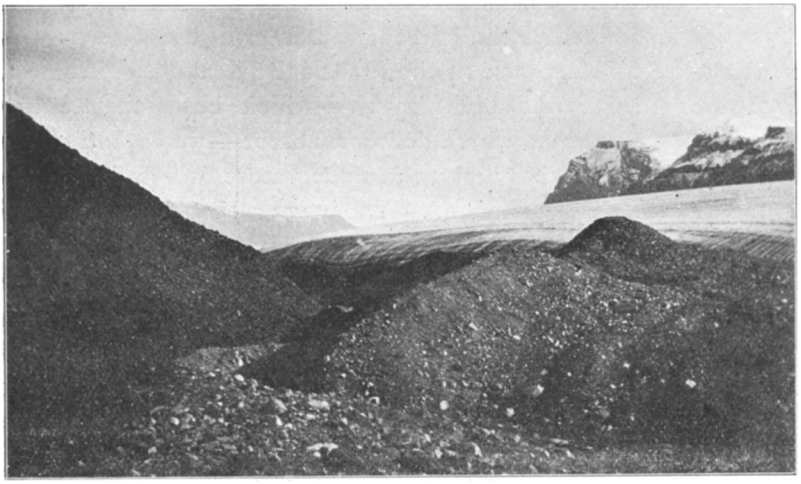

FIG. 55.—View of the northeastern border of the Krakokta glacier seen from a point near its junction with the Tuktoo glacier, looking southeasterly. A terminal moraine formed by the glacier occupies the right half of the foreground. On the left appears the lower part of the talus slope of the Sentinel nunatak. At its base and between it and the moraine is a stream which drains this part of the Krakokta and a part of the Tuktoo glacier. In the central portion of the figure the glacier is seen to have crept out upon its terminal moraine and to be overhanging the valley through which the drainage escapes to the Krakokta Cove at the head of Bowdoin Bay, which lies just beyond the center of the figure. The heights at the right are the northeastern promontory of the Redcliff peninsula.

northwestern limb of Bowdoin Bay, known as Krakokta Cove. In the portion opposite the Sentinel nunatak the ice does not push against the promontory, although it would do so if its border described a natural curve. The ice holds aloof, so to speak, and leaves space for a drainage stream and a terminal moraine. This is perhaps due to heat reflected from the nunatak.

This relationship may be seen in Fig. 55, as well as the much more interesting relationship of the glacier to its moraine. In the foreground, it will be observed that a fine terminal moraine has been formed outside the present border of the ice. In the center of the figure, however, it will be noted that the ice has advanced over this and has taken on a peculiar rounded border, much as though it were rolling forward over the moraine, while the bottom of the ice was being held back by friction. And this is not altogether an illusion, although the process scarcely amounts to rolling.

Quite in contrast with this aggressive disposition and this convex front is the concave front and retiring disposition shown only a few score rods back along the same border, where it falls behind the moraine shown in the foreground of Fig. 55. If we climb over this moraine and descend to the ice, we have the view shown in Fig. 56. It will be observed that the ice here has neither the tumid, advancing brow which it takes on a little farther east, nor the vertical wall which is common to the region, but a sloping face with a concave tendency. At the same time, the stratification assumes almost the regularity and symmetry of a musical staff. The amount of débris borne between the ice layers, as will be seen, is not very large, and seems to ill accord with the massiveness and coarseness of the moraine. It is to be noted, however, that the ice extends beneath the moraine, and that the latter may, therefore, owe its material largely to ice layers now concealed. The amount of buried ice could not be determined, but apparently its mass was large and constituted a considerable factor in the make-up of the moraine. On the melting of this the irregularities of the moraine will doubtless be accentuated.

Along this sloping border of the ice a suggestive view

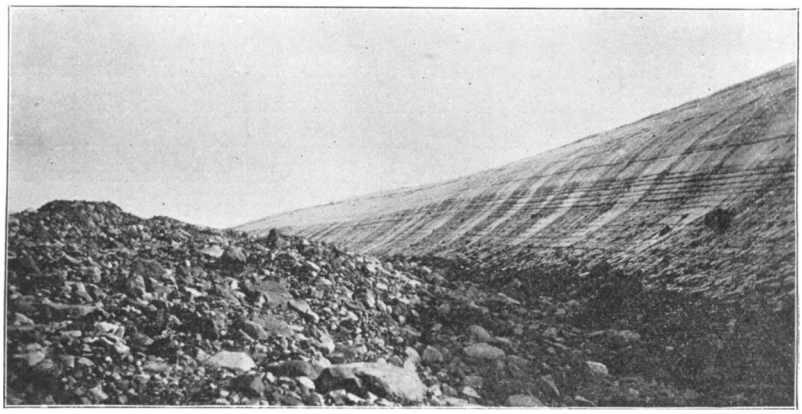

FIG. 56.—View of the edge of the Krakokta glacier within the moraine seen in Fig. 55, showing a sloping, slightly concave border, and remarkably parallel stratification.

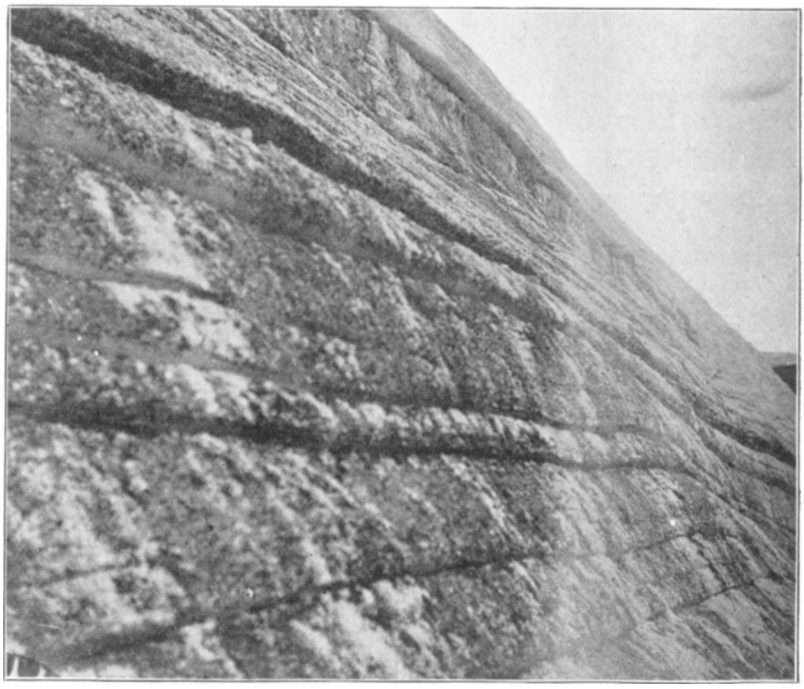

FIG. 57.—Near view of a portion of the sloping border of the Krakokta glacier, showing the strong individuality of the layers, and *perhaps* their individuality of motion.

(Fig. 57) was taken, which seems to bear upon the interpretation of the projection of the layers of the ice over each other alluded to in the descriptions of the two preceding glaciers. Attention was there called to the hypothesis that this projection was due to the superior melting of the débris-bearing layer. It seemed that there was no doubt as to the correctness of this interpretation in many cases, perhaps in most cases, but there appeared to be other cases in which the explanation was less satisfactory, if not untenable. In the photograph here taken, reproduced in Fig. 57, it will be seen that the under edge of several of the layers is notably cleaner and fresher than the outer edges which are roughened and débris-covered. The aspect is strikingly like that of layers which have moved over each other in such a way as to expose fresh under-edges. Unfortunately this particular feature did not attract my attention when on the ground, and I am only able to submit the evidence of the photograph for what it is worth. The strong individuality of the beds is at least worthy of note.

A short distance beyond the point where the ice is seen to be creeping over its moraine (Fig. 55), the border again retires within the moraine, and this continues perhaps half a mile in the course of which the moraine deploys into a fine series of conjoined morainic ridges, closely pressed together, but yet presenting distinct and sharp crests. These reach a height, according to a single aneroid measurement, of about 275 feet above the Cove and attain a breadth and massiveness which entitles them to rank among notable moraines. Here, however, as before, it was observed that ice was buried beneath the débris, and it was impossible to determine how far the massiveness of the moraine was rendered illusive by the included ice. There seemed ground, however, to believe that the melting of the concealed ice will cause a notable shrinkage of the moraine, and in doing this will greatly increase the irregularity of its surface. It will then doubtless become a typical "humpty-dumpty" moraine.

Following this stout moraine southward, the glacier is found again to be creeping out upon it. But here the ice not only

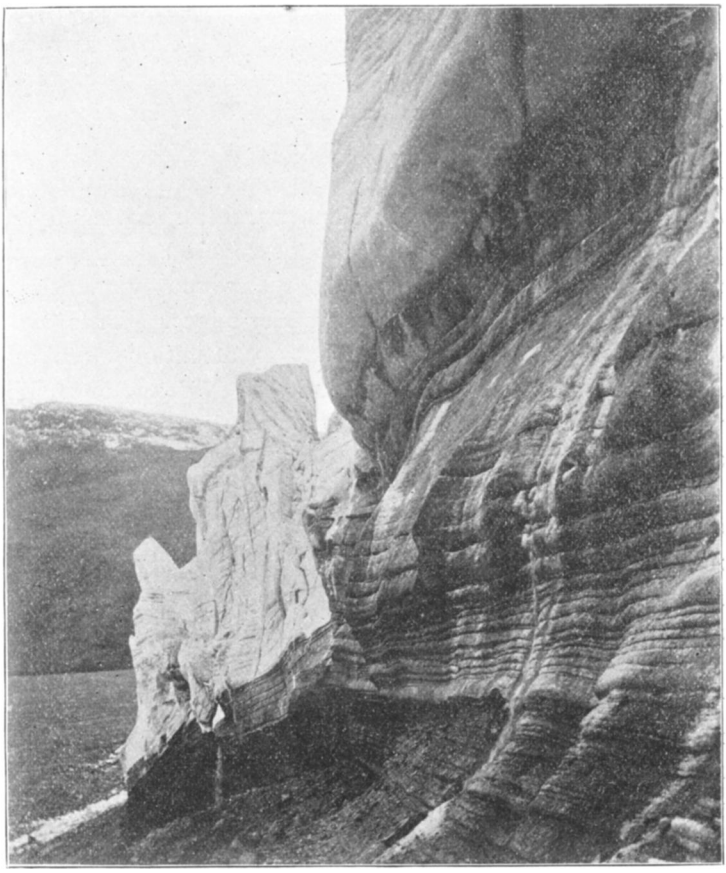

FIG. 58.—View of the east edge of the foot of Krakokta glacier, as seen from the moraine at the point where it is vanishing beneath the glacier.

creeps out upon it, but pushes entirely across it and down its outer slope until the glacier's foot rests essentially on the flat ground at the head of the bay. It has apparently made a descent on the outer slope of the moraine of more than 200 feet. Some allowance, of course, is to be made for the burial of the base of the glacier, and for illusions that may spring from the resting of the moraine on the edge of the ice. There is no room, however, to doubt that the moraine is really very massive, for the glacier is much crevassed where it crosses it, as shown partially in Fig. 58, and again in Fig. 59. Not only is it crevassed on the border, but the course of the overridden moraine may be traced along the surface of the glacier by the line of crevassing to which it gives rise. This crevassing was sufficiently pronounced to occasion some difficulty in crossing the upper surface of the glacier at the most remote point to which the ruptured tract could be traced, *i. e.* at the point where it merged into the crevassed field occasioned by the descent of the glacier from the upland, previously noted.

Fig. 58 shows the border of the Krakokta glacier at the point where the terminal moraine is disappearing beneath it. The ice wall on the right, which here resumes the vertical habit of the region, is notable for the distinctness and regularity of its stratification. It will also be noticed that here, as elsewhere, the beds at the base of the ice are inclined upwards. At the foot of the picture we catch a glimpse of the vanishing border of the moraine. In the center the crevassed border of the ice is seen very imperfectly—because of the oblique line of vision—as it descends the outer slope of the moraine. The border is riven into pinnacled masses and these are leaning and even toppling over as they descend the slope. The purity of the upper portion of the ice is in striking contrast to the dirtiness of the débris-set base. At the left and below there is a delta plain formed by wash brought from under the glacier at the foot of the cataract previously described.

If we now descend to this delta plain and ascend the heights opposite and reverse our line of vision, the general aspect of the upper surface of the glacier where it is creeping over the

FIG. 59.—View of the eastern border of the foot of the Krakokta glacier seen from the heights near the lower ice cascade.

moraine and down its outer slope may be viewed to advantage, as fairly well illustrated in Fig. 59.

We are here looking in a direction opposite to that from which we have approached in the preceding description. The right hand portion of the glacier in the middle foreground is the part which has pushed over the moraine, and crept down to the delta plain which occupies the low land at the right of the figure between the glacier and Krakokta Cove. The ice-strewn surface of the latter appears in the center of the picture. Near the middle of the picture the jagged edge of the glacier indicates the crevassing produced by its passage over the moraine. The line of crevassing across the upper surface of the glacier is not brought out in the picture. Beyond this jagged edge the moraine may be seen imperfectly as a dark mass. The promontory in the background is the Sentinel nunatak. The Bowdoin glacier lies at the right of this, debouching into the head of Bowdoin Bay. In the distance, at the right, are seen dimly two of the lobes of the main ice-cap. The latter covers the heights between these, but is not differentiated from the sky, in the photograph.

From the relations of the Krakokta glacier to its moraines it is obvious that, in recent years, it has been stationary or retreating at some points and advancing at others. The gains and loses very nearly balance each other. From the massiveness of the moraines and the manifest slowness of the glacial action it is probably safe to infer that the border has occupied nearly its present lines for a considerable period.

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